

# **QUANTIFYING THERMAL EXPOSURES AND EFFECTS FOR CENTRAL VALLEY ANADROMOUS SALMONIDS**

**Final Project – Presentation to address comments  
7 March 2019**

## The Team

- Ben Martin (Research Ecologist) – Team lead
- Alyssa FitzGerald (Postdoc) – Distribution and thermal effects modeling
- Sara John (NOAA affiliate/Specialist) – Temperature modeling, GIS processing/analysis
- Travis Apgar (PhD student) - Assisting with GIS, compiling phenology database

# Original goal

CWB Review of Literature regarding Thermal Tolerances of California Salmonids  
UC Davis Agreement #: D16-15901

## Define new thermal criteria for Central Valley salmonids

## Variation in Thermal Eco-physiology among California Salmonids: Implications for Management

May 31<sup>st</sup> 2018

Table 2.1: Thermal Metrics for Central Valley Anadromous Salmonids

		Chinook Salmon				Steelhead Trout	Metric	Citations
		Fall CS	Late Fall	Spring	Winter			
Life Stage	Egg	10-14°C <sup>1</sup> 13.3-13.9°C <sup>2</sup>	Unknown	Unknown	15.5°C <sup>3</sup>	Unknown	Minimum Mortality (~1884)	<sup>1</sup> Eklund and Ralston 2005 <sup>2</sup> Myrland and Clark 2005
	Aleuth	Unknown	Unknown	Unknown	Unknown	Unknown	Minimum Mortality (~1884)	
	Juvenile	17-20°C <sup>4</sup> 19.3°C <sup>5</sup>	Unknown	Unknown	Unknown	19-20.5°C <sup>6</sup>	Optimal Growth	<sup>4</sup> Myrland and Clark 2005 <sup>5</sup> Rich 1987 <sup>6</sup> Myrland and Clark 2005
	Smolt	28.8°C (8-19°C) <sup>7</sup>	Unknown	Unknown	Unknown	17.5-20.0°C (8-11-19°C) <sup>8</sup>	Critical Thermal Maximum	<sup>7</sup> Clark and Noyes 1999 <sup>8</sup> Myrland and Clark 2005
	Adult	<17°C <sup>9</sup>	Unknown	Unknown	Unknown	Unknown	Successful Spawning/Reproduction	<sup>9</sup> Myrland and Clark 2005
	Adult	21-24°C <sup>10</sup> 19-21°C <sup>11</sup>	Unknown	22°C <sup>12</sup>	Unknown	Unknown	Migration Success	<sup>10</sup> Strange 2010 <sup>11</sup> Eklund 1979 <sup>12</sup> Williams 2009

Labouratory conditions (unknown reference, clear water only) should be assumed unless specified by a 1 representing field-like laboratory conditions or a 2 representing data quantified from field observations. 3 represents population tested over from the Klamath River Basin.

### Authors

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Professor

# Original goal

## Define new thermal criteria for Central Valley salmonids

"there will likely exist conditions where **adherence to the Region 10 guidelines will become impossible** or where thermally-manageable zones will shrink."

"For most life-stages and species for which thermal performance data exists, the Region 10 guidelines appear protective against temperature-induced mortality, but may be sub-optimal, either managing water too be warm or too cool. In both cases, **exposure to sub-optimal temperatures can yield sub-lethal detrimental physiological and ecological effects**"

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## Variation in Thermal Eco-physiology among California Salmonids: Implications for Management

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## Questions

**Q1. How can we quantify the thermal environment experienced by Central Valley salmonid populations, and how does it differ from Region 10 populations?**

**Q2. Can we improve site-specific temperature management in the Central Valley by using thermal performance curves?**

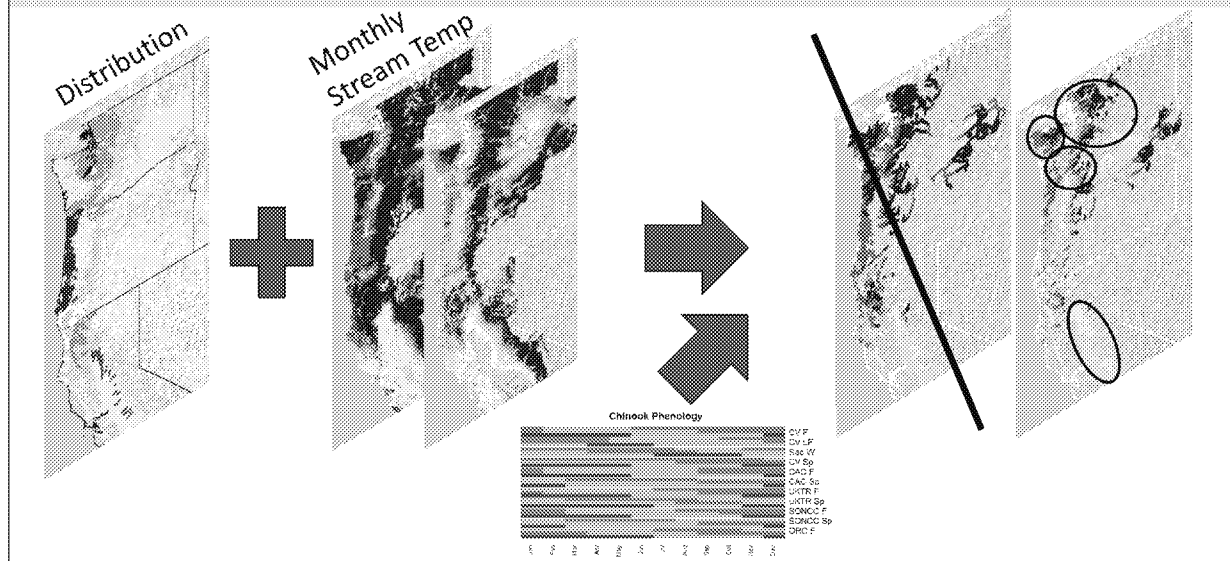
**Q3. What additional studies are needed in order to develop specific thermal thresholds for the different life stages of salmonids in the Central Valley?**

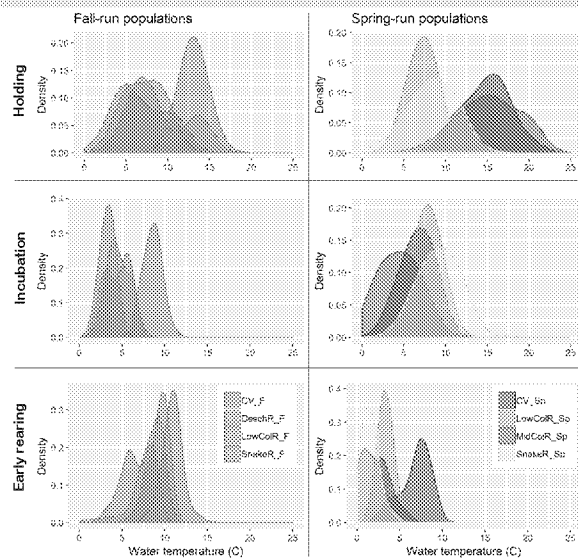
## **Part 1: What is the thermal environment experienced by Central Valley salmonid populations, and how does it differ from Region 10 populations?**

- Approach – three datasets required:
  - Where do anadromous populations/life-stages occur?
    - Distribution database
  - When do anadromous populations/life-stages occur?
    - Phenology database
  - What temperatures do salmon population experience when and where they occur?
    - Stream temperature

# Analyses

Part 1





**Figure 6.** Comparison of the thermal exposures of Chinook during peak holding, peak incubation, and early rearing in the Central California and mid-Columbia regions for fall-run (left panel) and spring-run (right panel) populations. The populations are Central Valley (fall and spring), Deschutes River (fall), Lower Columbia River (fall and spring), Mid-Columbia River (spring), Snake River (fall and spring).



## Q2. How can thermal performance curves improve temperature management of salmonid populations in the Central Valley?

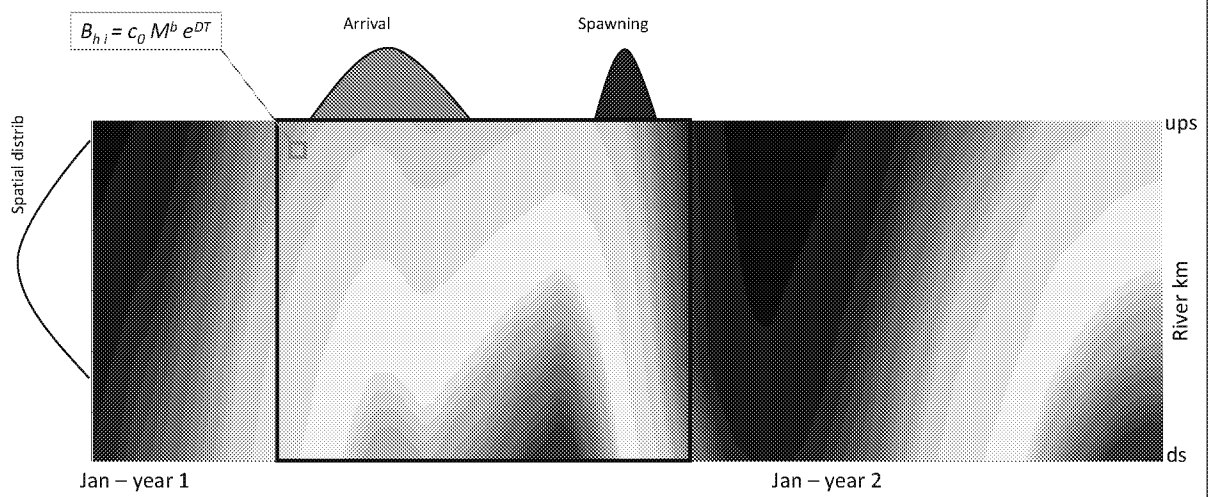
Part 2

Salmonid Uses During the Summer Maximum Conditions	Criteria
Bull Trout Juvenile Rearing	12°C (55°F) 7DADM
Salmon/Trout "Core" Juvenile Rearing <i>(Salmon adult holding prior to spawning, and adult and sub-adult bull trout foraging and migration may also be included in this use category)</i>	16°C (61°F) 7DADM
Salmon/Trout Migration plus Non-Core Juvenile Rearing	18°C (64°F) 7DADM
Salmon/Trout Migration	20°C (68°F) 7DADM, plus a provision to protect and, where feasible, restore the natural thermal regime

- "Region 10 guidelines...may be suboptimal" (Zillig et al. in prep)
- Replace a binary (above/below) threshold with a prediction for expected thermal impacts
- Determine thermal effects on different life stages
- Allow for prioritizing cold water resources in years/locations when Region 10 criteria cannot be met
- Can be updated as better laboratory or field data become available for specific populations

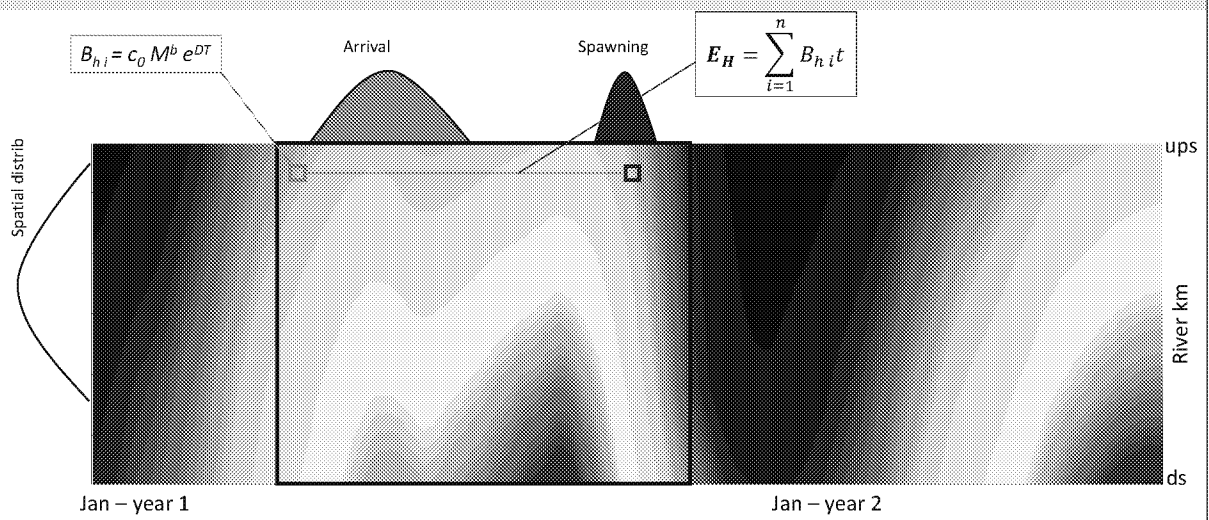
# Framework

## Part 2



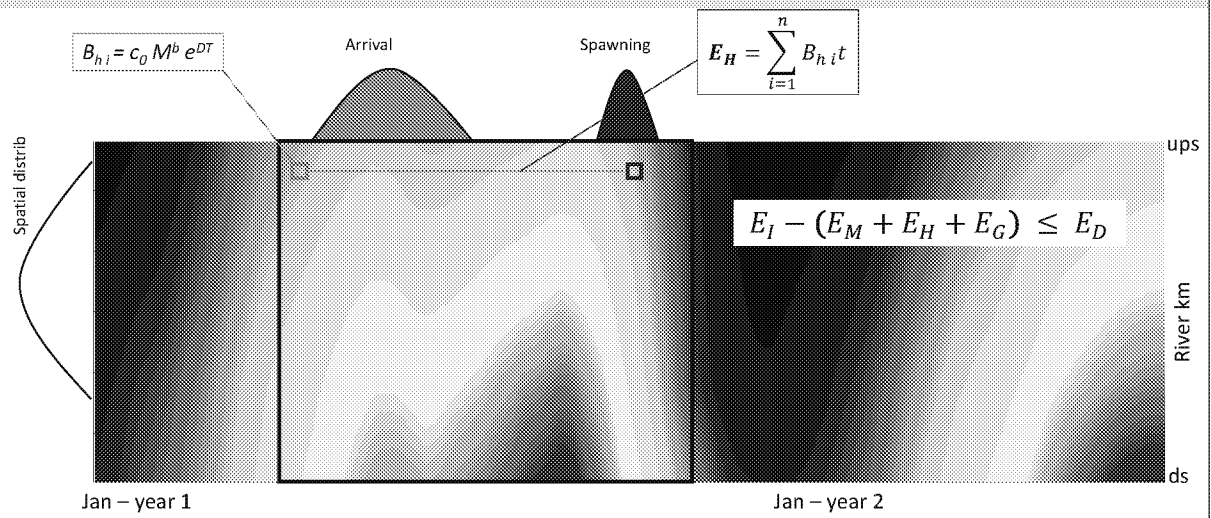
# Framework

Part 2



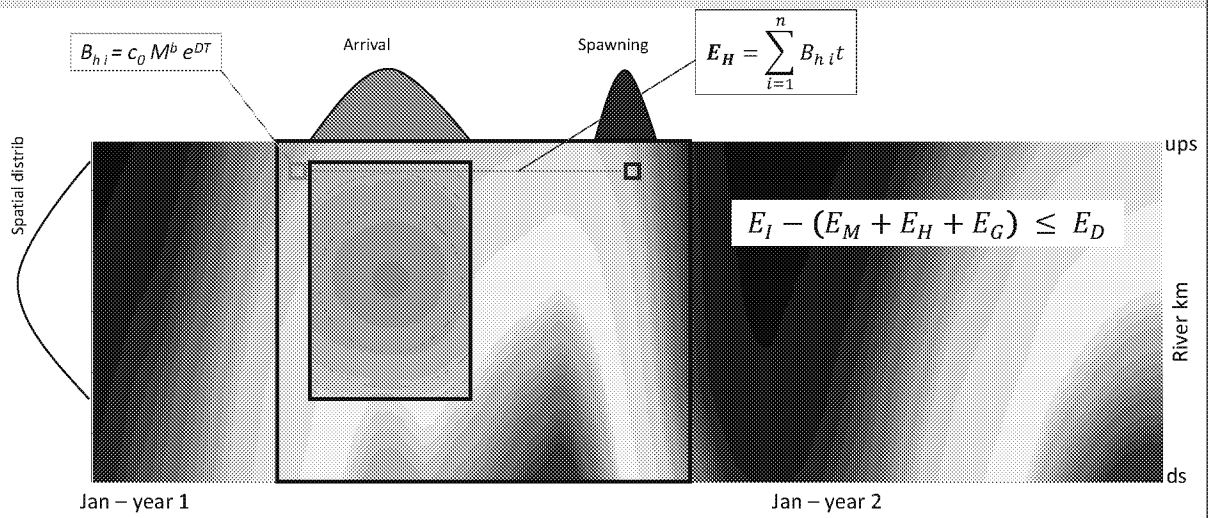
# Framework

Part 2



# Framework

Part 2



# Results

## Part 2

